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MIGRATING TO INTEGRATED ELECTRONIC MEDICAL RECORD: AN EMPIRICAL INVESTIGATION OF PHYSICIANS' USE PREFERENCE

Completed Research Paper

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Abstract

While the Health Information System (HIS) market is expanding fast, the fact remains that HIS capability in the majority of adopting hospitals remains low. In this study, we anchor on social exchange theory to study the effects of switching costs and contextual benefits on a physician's direct/indirect use preference, in the context of migration from stand-alone HISs to interoperable HISs supporting integrated electronic medical record. Survey results from 80 physicians in a public hospital reveal that previously identified cost and benefit factors exhibit different effects on a physician's use preference. Specifically, a physician who perceives higher learning cost, more technical support and higher group deindividuation is more likely to prefer indirect use of an interoperable Computerized Physician Order Entry System (CPOES). Comparatively, a physician who perceives higher transaction cost and higher incentive in using the interoperable CPOES is more likely to prefer direct use of the system.

Keywords: Health information systems, information technology adoption, personal health record (PHR)

Introduction

The past two decades have increasingly brought advanced technologies and management tools, such as the sophisticated patient information management and process coordination systems collectively known as Health Information Systems (HISs), to healthcare industries worldwide (Ash and Bates 2005; Bates et al. 2003; Miller and Sim 2004). For instance, in the United States, the HIS market grows from $23 billion in 2005 to $38 billion by 2009 and is projected to be further expanded by the pledged $19 billion HIS investment in the recently signed economic stimulus package (Mandl and Kohane 2009). Such growing trend is also prominent in developing countries. For instance, in China, intrigued by the vision of building electronic patient records throughout the country, at least $1.5 billion new HIS expenditure is expected in large Chinese hospitals.

While the figures give the impression that the HIS market is expanding fast, the fact remains that HIS capability in the majority of adopting hospitals remains low. HIMSS 2006 report shows 89.44% of hospitals have not transformed beyond stage two of the Electronic Medical Record (EMR) adoption model, in which stand-alone HISs are available but not integrated (Garets and Davis 2006). To meet the touted benefits of reducing medical errors and improving healthcare efficiency, it is imperative for hospitals to migrate towards integrated EMR, which allows paperless sharing and processing patient medical information throughout the hospital.

It has been widely noted that users' acceptance and their appropriate use of the system are critical to the success of an organizational Information System (IS) beyond the implementation process (DeLone and McLean 1992; Lewis et al. 2003). Despite the high degree of research interest in healthcare providers' HIS adoption, extant studies have traditionally examined the migration from paper-based manual systems to computerized HISs, i.e., "paper-system migration" (e.g., Ash and Bates 2005; Davidson and Chiasson 2005) and seldom did these studies explicitly examine the migration from stand-alone HISs to interoperable HISs supporting integrated EMR, i.e., "system-system migration". The users' perception towards these two types of migration could differ when viewed from the cost-benefit perspective. Specifically, users involved in paper-system migration can perceive improved work efficiency due to dramatic change of their workflows (i.e., switch from paper-based to paperless). Comparatively, the value of system-system migration is mostly accrued to patient and hospital management, e.g., reduction in operating costs and better analysis of healthcare quality. Nevertheless, the principle users of the system, e.g., physicians, may not perceive the direct benefits from such changes (Ash and Bates 2005; Bates et al. 2003). Indeed, previous literature shows that the lack of perceived direct benefits often results in users' resistance towards system-system migration (Kremers and Dissel 2000).

This study hence seeks to understand the factors driving physicians' use preference for HISs supporting integrated EMR in the context of system-system migration. Prior studies in IS adoption mainly treat use intention as a unidimensional construct in the voluntary context, i.e., the user makes to decision whether to use the system or not. Nevertheless, inside an organization, using an IS is often an integral part of employees' daily job (Karahanna et al. 1999). Although rarely having the opportunity to voluntarily choose the system in this setting, not all designated users do interact with the system directly nor use the system as mandated by organizational policies. Specifically, system users may often adapt the intended structures of an IS when they perceive the original structure is not appropriate (DeSanctis and Poole 1994; Orlikowski 1992), i.e., use deviation may occur.

Towards this end, this study further departs from the previous IS adoption literature by distinguishing a physician's direct and indirect use intention. Indirect use is often seen as a deviated use behavior employed by physicians who are resistant to change (Davidson and Chiasson 2005). When a physician intents to personally use the system, he or she is said to have "direct use intention". When a physician intents to make use of one or more intermediary users such as assistants or nurses to use the system on his or her behalf, he or she is said to have "indirect use intention". This study draws on the social exchange theory (Molm 1997) to propose that a physician's use preference (i.e., intent to directly or indirectly use the system) towards mandatory system-system migration is contingent on the various switching costs and contextual benefits. This view is interesting and highly relevant in the hospital context where there is an inherited cost-benefit asymmetry for a physician to use a HIS (Ash and Bates 2005; Bates et al. 2003). Our focus on the direct and indirect use preference and mandatory system-system migration process provides a more nuanced understanding of how social exchange theory can be applied in the organizational context.

The Trajectory of EMR Migration

The most noticeable evidence of the HIS proliferation in the healthcare industry would probably be the trend of moving toward Electronic Medical Record (EMR) for all patients (Chiasson et al. 2006). Also named as Computer-based Patient Record (CPR), EMR refers to electronically maintained medical information about patients in hospital and ambulatory environment, including medical history, clinical documentation, medications, laboratory and radiology test results (Garets and Davis 2006). Varying with different degrees of sophistication and functionality, EMR adoption in a hospital can be categorized into seven stages (Garets and Davis 2006). At the higher levels, various EMR-related HISs such as Computerized Physician Order Entry System (CPOES), pharmacy management system, and electronic medication administration record system, can interoperate with each other to support a robustly electronic exchange of patients' medical information (Ash and Bates 2005; Dansky et al. 1999). Towards this end, EMR operates as a hub of all activities inside the hospital, which not only improves the patient care, but also largely enhances hospitals' process efficiency and effectiveness (Garets and Davis 2006). In contrast, when a hospital's EMR adoption level is low, each EMR-related HIS tends to be a stand-alone application that computerizes single healthcare activity, such as medication administration or physician's medication order (Dansky et al. 1999). Under such circumstances, hospital management has less opportunity to monitor healthcare process and conduct internal analyses to assess service quality (Miller and Sim 2004).

Recent survey conducted by HIMSS Analytics shows that the vast majority of US hospitals have not achieved the electronic data exchange among various EMR-related HISs (Garets and Davis 2006). To meet higher EMR adoption levels, tremendous amount of work and investment must be done by hospitals to upgrade its existing HISs to enable

interoperability. The phenomenon of interest in this study is physician's migration across different CPOESs. As a core component of integrated EMR, CPOES is designed mainly for physicians to electronically prescribe medical orders, document clinical notes, and access order delivery information. A comprehensive CPOES, which is often embedded with decision support functions, can substantially reduce the medication errors associated with occurrence of illegible orders, inappropriate doses and incomplete orders (Ash et al. 2007; Colpaert et al. 2006).

While the decision to migrate to a HIS is often made by the hospital management, the success of the migration lies largely on whether the users accept the new system and how they decide to use the system in their daily work (DeLone and McLean 1992; Lewis et al. 2003). Prior qualitative studies observe that physicians, who possess high power in the hospital, often choose to indirectly use the CPOES by delegating their system-related tasks to intermediaries, such as assistants or nurses (Davidson and Chiasson 2005; Jensen and Aanestad 2007). Indirect use of an organizational IS can be theoretically understood from the adaptive structuration theory (AST) (DeSanctis and Poole 1994). According to AST, organizational users may often adapt the intended structures of an advanced IS to fit their particular work needs when they perceive the original structure is not appropriate. When confronted with a mandatory IS inside the organization, the users are not "controlled" by the system; rather, facilitated by resources and social norms inside the organization, they could change the patterns of the system use (Orlikowski 1992).

There could be several plausible explanations for the pervasion of indirect use. From the limited cognitive resource perspective, physicians need 1) to make many medical decisions during their daily work routine, 2) to work under constant stress and time pressure, and 3) to be attentive to details, such as be mindful of a patient's allergy and medical history before prescribing medications. In this view, delegating the interaction with the CPOES to others, such as the assisting nurses, appears to be a feasible and quick solution for many physicians (Kane and Alavi 2008). From the social power perspective, given the high autonomy and authority of their work, physicians may not experience significant pressure from the immediate supervisor to engage in direct use of the CPOES. While indirect use may relief physicians' workload, it could bring potential challenges for patient care delivery and cost management. For instance, transcription error, which is meant to be eliminated by directly using CPOES, could occur in the context of indirect use where intermediary users need to transcribe physician's prescription. In addition, indirect use could create additional manpower cost as hospitals tend to hire more healthcare professionals to as intermediary users to manage CPOES related tasks (Aarts et al. 2007). Despite the ubiquity of indirect use in the healthcare context and its influences on healthcare delivery, both academicians and practitioners still possess comparatively little knowledge on this topic. It is unclear in the mandatory system-system migration context, what factors can affect a physician's use preference of the interoperable CPOES (i.e., directly or indirectly use the system). Given the different focus of this study compared to previous IS adoption study which examines use intention as a unidimensional construct (i.e., use or not use the system), we expect the effects of antecedents on use preference could differ from previous literature.

Theoretical Background and Hypotheses

To yield a holistic view of a physician's use preference of an interoperable CPOES in the context of mandatory system-system migration, this study draws on the notion of social exchange as a theoretical foundation to examine both motivating and inhibiting factors that could influence a physician's decision. Social exchange theory posits that one's decision to perform a particular behavior can be understood from the perspective of social resource exchange, in which an individual gives up his or her own resources, tangible (such as money) or intangible (such as status), so as to receive positive resources from others (Cook and Whitmeyer 1992). Therefore, the individual is guided by the principle of maximizing anticipated positive outcomes and minimizing anticipated negative outcomes (Molm 1997). This view is also in accordance with the expectancy theory (Vroom 1964), which suggests organizational employees often weigh potential costs against benefits when making a decision.

While social exchange theory is originally applied to explain general social phenomena such as interpersonal relations, recently, researchers start to apply this theory in the context of information system use. For instance, Kankanhalli et al. (2005) draw on social exchange theory to explain benefit and cost factors for organizational users' contribution to electronic knowledge repository. In the context of this study, social exchange theory is appropriate as the theoretical foundation in two ways. First, the migration process incurs both benefits and costs to the physicians. For instance, to get used to the new system, physicians often need to spend time and effort in learning the new system, which could probably influence their patient care work. To alleviate the costs of the prospective users, incentives, such as monetary compensation are often provided by hospital management to motivate physicians' adoption. Towards this end, social exchange theory can best capture motivating/inhibiting factors that can affect a

physician decision compared to other adoption theories, such as technology acceptance theory. Second, a physician's decision to use the interoperable CPOES is perceived to exhibit a social exchange behavior, in which the anticipated benefits the physician can get is not only limited to economic incentive, but also include socially valued outcomes such as being able to identify with his or her peers.

Figure 1 depicts the research model. The central thesis of the study is that previously identified cost and benefit factors exhibit different effects on a physician's use preference of the interoperable CPOES, after controlling for socio-individual factors (i.e., gender, seniority, and education) and technology-related factors (i.e., perceived ease of use and perceived usefulness).

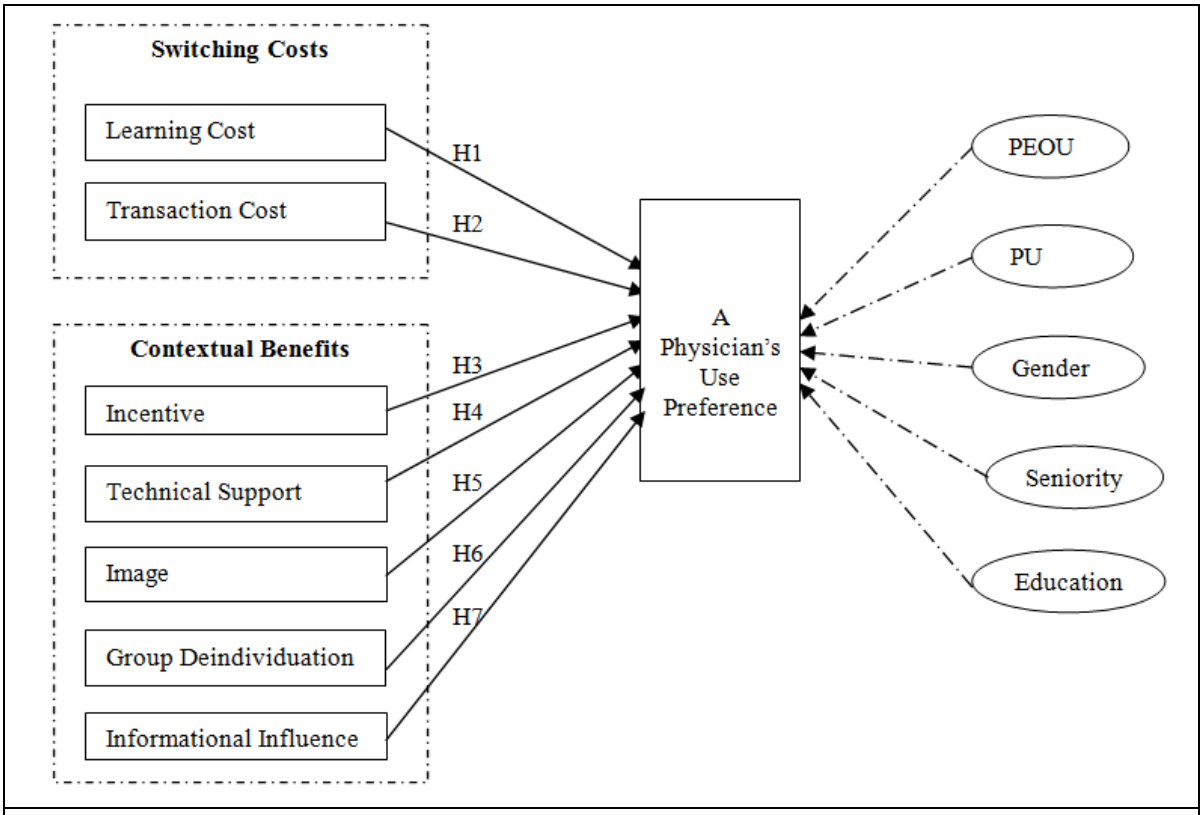

Figure 1 Research Model

Switching Costs

According to social exchange theory, costs refer to negative outcomes occurred in the exchange process, which decreases the possibility of the induced behavior (Molm 1997). During the process of system-system migration, the onetime monetary or effort costs a physician will encounter, namely switching costs (Burnham et al. 2003), can significantly influence the physician's use preference of the new system. Switching costs can manifest themselves into three dimensions: learning costs (i.e., effort spent to reach the same proficiency as previous behavior/relationship), transaction costs (i.e., cost to start a new behavior/relationship) and contractual costs (i.e., benefits foregone in relation to the previous behavior/relationship such as consumer loyalty discount) (Klemperer 1987). In this study, we focus on the first two types of switching cost because the contractual cost is unlikely to occur in this context where the system use is part of the job responsibility.

Learning cost refers to the effort and time required by an individual to acquire the skills in order to reach the same proficiency level as he or she had for the old system/product (Chen and Mitt 2002). The extent of such cost is associated with the degree of changes required to adopt the new system (Klemperer 1987). A physician who

switches to the interoperable CPOES not only needs to adapt the new ways to use existing functions (such as familiarize with different interfaces or different organizations of medication order sets), but also has to spends effort in learning new features (such as higher level of decision support functions). Such changes are likely to create addition burden to the physician who works under constant time pressure (Ash and Bates 2005). To the extent that indirect use does not demand effort in learning new system features, a physician is likely to prefer indirect use when he or she perceives migrating to the new system requires higher learning effort. Hence, we hypothesize,

H1: A physician who perceives higher learning cost in using the interoperable CPOES is more likely to prefer indirect use of the system.

Transaction cost, as the second type of switching cost, refers to negative outcomes occur when the individual starts a new relationship (such as using interoperable CPOES) or terminates the existing relationship (Klemperer 1987). In the current context, physicians do not have to directly bear the costs of purchase, implementation and maintenance of the new system, which are at the expense of the hospital (Ash and Bates 2005). Nevertheless, migration to the new system could bring physicians some hassles to their daily work. Specifically, physicians switching to a new CPOES often experience lower service quality at the initial period because they tend to spend longer time and encounter more errors when using the unfamiliar system (Bates 2005; Miller and Sim 2004). While prior literature often hypothesizes a negative relationship between transaction cost and physician's voluntary adoption, we propose such cost could be beneficial to reduce the intention to indirectly use the interoperable CPOES. To the extent that the problem of lower service quality affects all potential users who are new to the system, delegating the system-related work to others may cause errors which undermine the physician healthcare delivery. As any medical error could seriously affect a physician's appraisal, physician hence tends to directly use the system, which can help him or her better control the healthcare delivery. Hence, we hypothesize,

H2: A physician who perceives higher transaction cost in using the interoperable CPOES is more likely to prefer direct use of the system.

Contextual Benefits

In the social exchange process, benefits are defined as outcomes that are perceived positive, which increase an individual's commitment to participate in the exchange behavior (Molm 1997). Inside an organization, contextually favorable factors have been proposed as critical benefits an individual employee desires to pursue (Lamb and Kling 2003; Tan and Zhao 2003). Based on different personal goals, benefits an individual expects inside an organization can be classified into three categories: 1) obtain explicit and favorable outcomes; 2) establish or maintain satisfactory relationship with others, and 3) receive valuable information related to the behavior (Kelman 1958). In line with this classification, five variables – rewards, technical support, image, group deindividuation, and informational influence have been identified to constitute perceived contextual benefits for a physician to use the interoperable CPOES.

Explicit and Favorable Outcomes

An individual's commitment can be aroused by attractive outcomes explicitly promised by others (Kelman 1958). To encourage the adoption of a certain behavior, organizational management often provides some material rewards, such as bonus, to the employees. Supervisors, serving as champions, may also give their recognition or favorable appraisals to subordinates who proactively perform the behavior. Indeed, providing explicit incentives from hospital management or supervisor is an often recommended strategy to motivate physicians' use of the CPOES (Miller and Sim 2004). Compared to indirect use, a physician who chooses to directly use the interoperable CPOES can proactively demonstrate his or her proficiency, and hence is more likely to receive rewards offered by the hospital management or the supervisor. Towards this end, when the perceived incentive is high, a physician driven by the objective to maximize benefit will be more willing to choose direct use of the system. Hence, we hypothesize,

H3: A physician who perceives higher incentive in using the interoperable CPOES is more likely to prefer direct use of the system.

Another favorable resource offered in the system-system migration process is the technical support. As an important aspect of facilitating condition in the organization, technical support refers to "the degree to which an individual beliefs that an organizational and technical infrastructure exists to support the use of the system" (Venkatesh et al. 2003, p. 453). Previous research shows that an individual user who can receive more technical support is likely to

accept the technology as such support eases the use behavior (Thompson et al. 1991). In the context of this study, users who face problems with the interoperable CPOES can seek technical help, either from the system user manual or supporting staff such as informatics officers or clinical super users (Ash et al. 2003). When a physician can obtain strong technical support, it becomes safer for him or her to choose indirect use (e.g., the assistant will be able to receive help whenever encountering difficulties) so as to relieve the extra burden of using the new system. Hence, we hypothesize,

H4: A physician who perceives more technical support in using the interoperable CPOES is more likely to prefer indirect use of the system.

Satisfactory Relationship

Apart from explicit rewards, an individual inside the organization can also be attracted by the possibility to establish or maintain a self-defined satisfactory relationship with others, i.e., identification (Kelman 1958). The sophistication of the interoperable CPOES brings an opportunity to a physician who can proficiently use the system to establish a positive reputation among his or her peers. Specifically, image refers to "the degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat 1991, p.195). Under the circumstances where a physician anticipates that using the system is associated with an increased image among the peers, he or she is more likely to have higher commitment and hence decides to engage in direct use of the system. Hence, we hypothesize,

H5: A physician who perceives higher image in using the interoperable CPOES is more likely to prefer direct use of the system.

Group deindividuation takes effect when an individual perceives that performing the induced behavior can help maintain the positive relationship with his or her social group (Reicher et al. 1995). Individual, who belongs to a social group, tends to achieve a meaningful sense of identity within the group. Therefore, an individual may decide to perform the behavior conformed to the norms defined by the social group (Cialdini and Goldstein 2004). In the context of this study, physicians' indirect use of a CPOES has been observed as a common phenomenon due to their heavy workload and superior authority inside the hospital (Davidson and Chiasson 2005). Given the prevalence of indirect use, a physician is likely to exhibit a propensity to follow such norm since indirect use requires less effort to do so. Therefore, we hypothesize,

H6: A physician who perceives higher group deindividuation in using the interoperable CPOES is more likely to prefer indirect use of the system.

Valuable Information

The last category of contextual benefit is related to the behavior itself. Convincing and logical information provided by other people may be useful to aid an individual's understanding of a specific behavior. Informational influence takes effect when one's judgment is affected by such information and he or she realizes the value of performing the induced behavior (Cialdini and Goldstein 2004; Kelman 1958). In the context of this study, through others' explicit persuasion or observation of other physicians' use of interoperable CPOES, a physician may go through an internalization process and accept the value of the migration, e.g., increase in healthcare quality and process management efficiency. While previous literature suggests a positive relationship between informational influence and one's adoption of a particular behavior (e.g., Erchul et al. 2001), empirical evidence observes a significant gap between physicians' recognition of the system value and their propensity to engage in direct use, primarily due to the lack of commitment in making the effort (Ash and Bates 2005). To this end, a physician is more likely to choose indirect use, which is a relatively easier way to acquire the benefits of the interoperable CPOES without expending excessive effort and causing significant distraction to his/her work. Hence, we hypothesize,

H7: A physician who receives higher informational influence in using the interoperable CPOES is more likely to prefer indirect use of the system.

Research Methodology

To validate the proposed model, survey methodology was used in this study given its abilities to provide a basis for establishing generalizability; allow results to be easily replicated; and has statistical power (Neuman 2003). The unit of analysis in this study is individual physician in the hospital. We aim to explain and predict the use preference of individual physicians with regard to his or her intention to directly or indirectly use the interoperable CPOES before the actual system-system migration. A field survey was conducted at a large public general hospital in China, which was in the process of migrating inpatient CPOES from a stand-alone system to an integrated system. In accordance with previous literature (e.g., Karahanna et al. 1999), the choice of a single organization is more effective in detecting micro level effects because this choice helps control the effects of organizational level variables (such as different CPOE packages and hospital size) on individual use behavior. The new CPOES allows physicians to enter patient's admitting, transfer, and discharge information, prescribe inpatient medication and make various test orders. Test results from ancillary department systems (e.g., laboratory) can be electronically transferred to the new CPOES. Similarly, information entered by nurses in the nursing station (e.g., patients' allergies and drug reaction, vital signs, and medication administration record) can be simultaneously reflected on the new CPOES. The system migration in the studied hospital is taken in a phased approach. At the time we conducted the survey, nearly half of departments had installed the new interoperable CPOES while the other half planned to migrate in several months time. The use of the system, both the existing and new systems, was mandatory, which means physicians were expected to use the system, either directly or indirectly, in the course of their daily work.

Scale Development

As far as possible, constructs were measured using validated questions from previous studies to facilitate the validity of measures and comparison of results across studies. In the case when we cannot find previously validated measurement, we developed the measurement based on a review of the relevant literature and were subsequently tested for validity. As suggested by the contact physician in the surveyed hospital, we selected two items, which performed best in the conceptual validation stage, to measure each construct. This is to control the total length of the survey to improve response quality, given physicians' tight work schedule. Table 1 summarizes the operationalization of constructs examined in this study. It should be noted that the sources to provide different contextual benefits can vary. For instance, incentives were issued by hospital management and supervisor, both of whom had legitimate power to promise explicit incentives. Similarly, given the fact that the new system had yet to be implemented in respondents' departments, informational influence was best exerted by hospital peers outside the departments, who already had certain experience in using the new system. The dependent variables use preference is a binary variable to assess respondent's preference for two use modes, i.e., direct and indirect use. Each question is measured in a 7-point Likert Scale (Strongly disagree – Strongly agree) if not specified explicitly.

Table 1 Definition and Measurement of Constructs	
Category	**Measurement**
Learning cost (*Burnham et al. 2003*)	1. Learning to use features offered by the interoperable CPOES will take me time. 2. Getting used to how the interoperable CPOES works will be difficult.
Transaction cost (*Self-developed*)	1. Switching to the interoperable CPOES will involve hidden costs to my healthcare work. 2. Switching to the interoperable CPOES will result in some unexpected hassle to my healthcare work.
Incentive (*O'Reilly and Chatman's 1986*)	1. How hard I work on the interoperable CPOES will be directly linked to how much I am rewarded from the hospital's management. 2. Unless I will be recognized by my supervisor, I see no reason to spend extra effort in using the interoperable CPOES.
Technical support *(Thompson et al. 1991)*	1. Guidance will be available in using the interoperable CPOES. 2. A specific person (or group) will be available to provide assistance for solving the difficulties faced in using the interoperable CPOES.
Image *(Venkatesh and Davis 2000)*	1. Using the interoperable CPOES will improve my image among my departmental peers. 2. Using the interoperable CPOES will be a status symbol with my departmental peers.
Group deindividuation (*Self-developed*)	1. Using the interoperable CPOES will help me identify with my departmental peers. 2. Using the interoperable CPOES will make my behavior in accordance with my departmental peers.
Informational influence (*Self-developed*)	1. I can observe the value of using the interoperable CPOES from my hospital peers. 2. My interaction with my hospital peers allows me to understand why using the interoperable CPOES will be important for me.
Use preference (*Self-developed*)	In doing my job in the inpatient department, which mode of using the interoperable CPOES do you prefer? Use it directly by myself [__] Let others use the interoperable CPOES for me [__]
Perceived usefulness (PU) *(Venkatesh and Davis 2000)*	1. Using the interoperable CPOES will enhance the effectiveness of my work. 2. Using the interoperable CPOES will enable me to accomplish my tasks more quickly.
Perceived ease of use (PEOU) *(Venkatesh and Davis 2000)*	1. Learning to operate the interoperable CPOES will be easy for me. 2. My interaction with the interoperable CPOES will be clear and understandable.
Gender (*Self-developed*)	What is your gender? Male [__] Female [__]
Seniority (*Self-developed*)	What is your seniority? Chief physician [__] Assistant chief physician [__] Attending physician [__] Resident physician [__] Intern [__] Others (please specify):_____
Education (*Self-developed*)	What is your highest degree of education received? Diploma and below [__] Bachelor [__] Master [__] Ph.D. [__] Others (please specify) _____

* The actual survey was administered in the *Chinese* language.

Conceptual Validation and Field Survey

Several measures were taken to validate the survey instrument. First, we consulted several IS researchers to identify and rectify potential problems due to the framing and phrasing of the questions. Second, two rounds of sorting, one unlabeled and one labeled, were conducted by postgraduate IS students (6 participants for each round). We made some modifications on the items based on the concerns raised by the participants. Third, two independent bilingual postgraduate students translated the questionnaire into Chinese and then retranslated into English. The authors

compared the translated version with the original questionnaire and made necessary changes. Fourth, to ensure face validity, the survey questionnaire was sent to two experienced physicians in the surveyed hospital. Based on their comments, the authors made some modifications in the phrasing and framing of the questions.

We sent a survey package consisting of a cover letter stating the study objective and the survey questionnaire to physicians in the studied hospital whose departments would implement the interoperable CPOES in several months time. It was also required that they had prior experience in using the stand-alone CPOES, directly or indirectly. We obtained the list of physicians from the Informatics Department of the hospital. To improve the response validity, the definition and description of the interoperable CPOES were included in the survey instrument. To increase the response rate, RMB 10 dollars (equivalent to around US$1.5) was donated to a charity foundation in China for each complete questionnaire received. Physicians who participated in the previous face validity test were excluded from the study. To protect the privacy of the respondents, no personally identifiable information, such as name or email address was required for the survey. The first author made several personal visits to the hospital to increase the response rate. Among the 100 questionnaires sent out, 85 responded, yielding a response rate of 85%. This response rate is considered very high given the tight schedule of physicians. 5 incomplete responses were excluded from further analysis because we could not recover the missing data due to the anonymous nature of our survey. A total of 80 complete entries were recorded.

Table 2 Demographic Information

Variables	Category	Frequency (n=80)	Percent
Gender	Male	49	61.2
	Female	31	38.8
Age	24-29	23	28.8
	30-34	19	23.8
	35-39	16	20.0
	40-44	11	13.8
	45-50	6	7.5
	>50	5	6.2
Education	Bachelor	57	71.3
	Master	21	26.2
	Ph.D.	2	2.5
Work experience (year)	0-2	8	10.0
	3-5	14	17.5
	6-8	19	23.8
	9-11	16	20.0
	12-14	7	8.8
	>15	16	20.0
Seniority	Chief physician	11	13.8
	Assistant chief physician	19	23.8
	Attending physician	28	35.0
	Resident physician	15	18.8
	Intern	2	2.5
	Others	5	6.2

Data Analysis

Table 2 presents the demographic information of the survey respondents. It should be noted that a medical school graduate who holds a Bachelor degree is qualified to be a physician in Chinese healthcare system. As our dependent variable is binary, the logistic regression was performed to estimate a model with use preference as the dependent variable. When a respondent preferred indirect use, use preference was set to 0. When a respondent preferred direct use, use preference was set to 1. All statistical tests were assessed at 5% level of significance.

Evaluating the Measurement Model

The strength of the measurement model was assessed by the convergent and discriminant validities of all reflective multiple-items constructs. Convergent validity reflects the uni-dimensionality of the constructs and was assessed using item reliability, composite reliability of constructs and the average variance extracted (AVE) (Hair et al 1998). A score of 0.5 is the threshold to deem the AVE acceptable for a construct. Furthermore, the Cronbach's Alpha and composite reliability values greater than 0.707 show good convergent validity (Nunnally 1978). Table 3 shows in general, observed scores exceed the acceptance levels, which indicate satisfactory convergent validity.

Table 3 Assessment of Convergent Validity

Dimensions	Item Reliability	AVE	Composite Reliability	Cronbachs Alpha
Learning cost		0.773	0.872	0.727
Learning cost1	0.810			
Learning cost2	0.994			
Transaction cost		0.727	0.842	0.628
Transaction cost1	0.822			
Transaction cost2	0.883			
Incentive		0.818	0.900	0.785
Incentive1	0.940			
Incentive2	0.868			
Technical support		0.797	0.887	0.751
Technical support1	0.926			
Technical support2	0.858			
Image		0.672	0.800	0.557
Image1	0.939			
Image2	0.681			
Group deindividuation		0.809	0.894	0.765
Group deindividuation1	0.991			
Group deindividuation2	0.888			
Informational influence		0.854	0.921	0.833
Informational influence1	0.950			
Informational influence2	0.897			
PU		0.863	0.9263	0.869
PU1	0.871			
PU2	0.983			
PEOU		0.705	0.8262	0.591
PEOU1	0.779			
PEOU2	0.896			

Discriminant validity reflects the extent to which the indicators for each construct are distinctly different from indictors in other constructs, and was assessed using factor analysis and construct correlation in this study. Factor loadings of above 0.7 are considered as good. As depicted in Table 4, all indicators loaded correctly on their intended construct than on other constructs. The second method is to assess whether the square root of AVE for a construct is larger than its correlations with other constructs. As shown in Table 5, all reflective constructs satisfy this criterion. Generally, the results indicate strong evidence of convergent and discriminant validities.

Table 4 Rotated Component Matrix

	Component								
	1	2	3	4	5	6	7	8	9
Learning cost1	0.242	0.094	-0.130	-0.097	0.304	**0.754**	0.173	0.183	0.048
Learning cost2	0.129	0.158	0.289	0.227	0.129	**0.794**	0.145	0.062	0.030
Transaction cost1	-0.115	-0.034	0.0263	0.114	0.045	0.143	**0.886**	0.101	0.063
Transaction cost2	0.237	0.377	0.085	0.193	0.161	0.133	**0.682**	-0.084	-0.056
Incentive1	0.029	0.011	0.063	**0.812**	-0.027	0.070	0.235	0.213	0.226
Incentive2	-0.004	0.270	0.051	**0.874**	0.082	0.039	0.050	0.019	0.081
Technical support1	0.192	0.133	0.112	0.159	**0.839**	0.202	0.120	0.060	0.117
Technical support 2	-0.057	0.290	0.392	-0.154	**0.676**	0.220	0.064	0.101	0.082
Image1	0.353	0.191	-0.065	0.037	0.184	-0.079	0.281	0.289	**0.689**
Image2	0.004	0.083	0.157	0.276	0.051	0.113	-0.098	-0.113	**0.815**
Group deindividuation1	0.014	**0.794**	-0.003	0.204	0.069	0.143	0.139	0.292	0.153
Group deindividuation2	0.072	**0.876**	0.134	0.099	0.206	0.073	0.027	-0.074	0.064
Informational influence1	0.393	0.230	**0.768**	0.146	0.178	0.128	0.080	0.070	0.037
Informational influence2	0.151	-0.021	**0.869**	0.028	0.143	0.025	0.019	0.197	0.081
PU1	**0.892**	0.009	0.183	-0.073	0.131	0.105	-0.011	0.113	0.023
PU2	**0.854**	0.073	0.199	0.095	0.007	0.191	0.015	0.136	0.153
PEOU1	0.088	0.082	0.256	0.091	-0.116	0.334	0.016	**0.733**	0.187
PEOU2	0.262	0.081	0.116	0.173	0.334	-0.030	0.059	**0.728**	-0.161

Table 5 Inter-Correlations among Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
Use preference (1)	1												
Learning cost (2)	-0.198	0.879											
Transaction cost (3)	0.137	0.378	0.853										
Incentive (4)	0.515	0.204	0.344	0.904									
Technical support (5)	-0.301	0.476	0.316	0.151	0.893								
Image (6)	-0.025	0.227	0.204	0.382	0.271	0.820							
Group deindividuation (7)	-0.128	0.347	0.343	0.370	0.428	0.336	0.899						
Informational influence (8)	-0.186	0.378	0.325	0.285	0.435	0.354	0.548	0.924					
PU (9)	-0.095	0.370	0.145	0.098	0.287	0.294	0.168	0.396	0.929				
PEOU (10)	-3.1E-17	0.382	0.216	0.282	0.334	0.239	0.274	0.221	0.399	0.840			
Gender (11)	-0.018	0.095	-0.084	-0.122	-0.018	-0.054	-0.067	-0.005	0.028	0.048	1		
Seniority (12)	-0.136	0.031	-0.036	-0.124	-0.022	0.104	-0.085	-0.061	0.191	-0.016	0.010	1	
Education (13)	0.049	-0.174	0.052	0.054	0.002	-0.001	0.070	-0.025	-0.090	-0.012	-0.115	-0.109	1

* The diagonal shows the square root of the average variances extracted.

Testing the Structural Model

After confirming good psychometric properties, we next examined the structural model by assessing the explanatory power (Nagelkerke R^2) and significance of paths using the logistic regression in SPSS 16.0. Table 6 presents the results of analyses for three models: the theoretical model, the control model and the full model including all control variables. Nagelkerke R^2 provides approximates R^2 in the three models. A Nagelkerke R^2 value of 70.5% was obtained for the theoretical model and 74.3% was obtained when we included all control variables.

Table 6 Results of Logistic Regression Analyses: Path Coefficients and Variance Explained

	Theoretical Model	Control Variables Only	Full Model	Hypothesis Testing
Learning cost	-1.283*		-1.587*	H1 was supported
Transaction cost	1.476*		1.953*	H2 was supported
Incentive	4.791**		5.573**	H3 was supported
Technical support	-2.152**		-2.483**	H4 was supported
Image	-0.786		-0.563	H5 was not supported
Group deindividuation	-1.860**		-2.256**	H6 was supported
Informational influence	0.549		0.757	H7 was not supported
Perceived usefulness	-	-0.272	-0.236	
Perceived ease of use	-	0.104	-0.464	
Gender	-	-0.051	0.847	
Seniority	-	-0.188	-0.565	
Education	-	0.044	-0.331	
Cox & Snell R^2	52.1%	2.5%	55%	
Nagelkerke R^2	70.5%	3.4%	74.3%	

* Significant at 5% level of significance ** Significant at 1% level of significance.

The results showed that the significance of paths remained after adding in control variables. Therefore, the results of the hypotheses tests were reliable and independent of the influences from the control variables. Our examination of the theoretical and the full models reveals that out of 7 hypotheses, 5 were supported. Both switching costs, i.e., learning cost and transaction cost, showed an expected significant relationship with use preference, i.e., H1 and H2 were supported. In terms of contextual benefits, incentive, technical support, and group deindividuation were observed to have hypothesized significant relationships with use preference, i.e., H3, H4, and H6 were supported. However, image and informational influence did not have a significant relationship with use preference, i.e., H5 and H7 were not supported.

Discussion and Implications

This study constitutes one of first few empirical studies that systematically test the antecedents of IS use preference in the context of mandatory system-system migration, an area that has received scant attention by previous IS adoption and healthcare literature. As hypothesized, two switching costs (i.e., learning cost and transaction cost) and three contextual benefits (i.e., incentive, technical support, and group deindividuation) were significantly associated with a physician's use preference. Drawing on social exchange theory, our results provide strong empirical evidence for the proposition that switching costs and contextual benefits do exert a significant proportion of variance (i.e., Nagelkerke $R^2 = 70.5\%$) in a physician's use preference of an interoperable CPOES.

In light of difference between the focus of previous adoption studies (i.e., voluntary adoption in terms of intention to use vs. not use) and the focus of this study (i.e., mandatory use preference in terms of intention to direct vs. indirect use), we explore and expect different effects of costs and benefits exhibited on the dependent variable. Consistent with our proposition, we observed that two types of switching costs exerted different influences on a physician's use preference. While higher learning cost increased a physician's likelihood to choose indirect system use, higher economic cost decreased such possibility. Similarly, contextual benefit factors also played different roles in influencing a physician's use preference of the interoperable CPOES. Our findings provide a much needed evidence on the necessity to respond to the recent call for extending the IS adoption research beyond the voluntary context and examine the use in a broader conceptualization (Benbasat and Barki 2007).

Contrary to our hypothesis 5 and past studies, the relationship between image and use preference was not significant. In other words, the image gained from proficiently using the interoperable CPOES may not be an influential determinant for a physician's system use preference. A plausible explanation for this discrepancy is that the system use is not central to a physician's assessment. Specifically, the medical expertise to diagnose and treat a patient has long been recognized as the primary criterion to evaluate a physician. Hence, the physician may not value the possible recognition gained in relation to the system use.

Based on our findings, informational influence did not exert a significant effect on a physician's use preference. Although a physician is convinced of the value of using the interoperable CPOES, he or she may not be ready to make the decision whether to directly or indirectly use the system. Indeed, the disconnection between a physician's acceptance and their use intention has been observed in the previous healthcare literature (Ash and Bates 2005). Such discrepancy could be possibly due to the nature of healthcare work and the source of influence. Specifically, given the sophisticated nature of healthcare work, the workflows and requirements to use a HIS in different departments could vary substantially. Towards this end, the effects of informational influence could be weakened when the information is delivered by peers outside the department because the same value may not hold in the physician's department. Future research could seek to validate this conjecture by exploring the moderating effects of source of influence and nature of work on the relationship between informational influence and use preference.

It is interesting to note that in the full model, while our theoretical antecedents remained significant, technology-related factors (i.e., perceived usefulness and perceived ease of use) as control variables, were not significant. In other words, the variables traditionally used to predict IS adoption in the voluntary context were no longer significant to predict use preference in the mandatory context, in which using the system is an integral part of the user's job requirement. This is in line with arguments that extant IS theories mainly developed in the voluntary context may not be applicable to explain complex social interactions in organizations (Lamb and Kling 2003).

Before proceeding to discuss the implications of our study, it is imperative that we understand its limitations. First, the hospital in which we conducted the survey was in the process of a phased system-system migration. While this site selection makes this study interesting and valuable (i.e., respondents could observe the system use by peers in the hospital who had already used the system), we realize that the results may not be generalizeable to all hospitals'

migration process. Future research could seek to complement this study by surveying physicians in hospitals which adopt the big-bang migration approach. Second, our study was conducted in one hospital in the Chinese healthcare context, which could be different from western healthcare system. Future study could conduct a cross-country study in multiple hospitals to validate the research findings. Third, while this study assesses the physician's use preference before the migration, a longitudinal study could be conducted to compare the different effects of antecedents before and after the migration. Forth, while this study focuses on the physicians' perceived benefits and costs in relation to CPOES use, other variables, such as specialty, patient load, and amount of information typically entered on a chart, could also exert significant influences on a physician's use preference. Future research could explore the roles of these variables to complement the findings in this study.

Notwithstanding the limitations, which set the stage for future research, this study advances theoretical development in the area of individual adoption of an organizational IS in general and physicians' migration preference of a HIS in particular. First, this study constitutes one of the first few studies to systematically examine a physician's direct/indirect use preference for a mandatory HIS. While indirect use by physicians is a commonly observed type of use deviation in hospitals (e.g., Davidson and Chiasson 2005), this construct has received scant theoretical scrutiny in the literature so far. Towards this end, this study contributes to IS adoption literature by providing a broader conceptualization of the IS use intention (DeLone and McLean 2003).

Second, this study adds to the healthcare literature by providing a more nuanced understanding of a physician's use preference in the process of system-system migration. Despite the increasing demand and distinct characteristics of system-system migration, related prior studies typically examine a general system adoption behavior without explicitly considering system-system migration. The findings of this study unveil several important factors that can motivate or inhibit a physician's direct/indirect use preference in this process. To this end, this study could serve as an exploratory study to direct more research attention to be paid on this area.

Third, this study also contributes to the theory development of antecedents of IS adoption in the organizational setting, where using the system is often considered as an integral part of the users' job requirement. Contrary to prior use studies that focus on system-related characteristics as antecedents, our results imply that in the organizational context, several contextual benefits and costs, such as identification with peers and impact on work performance may be more important to predict a user's system use preference than technologies *per se*. This finding enhances our theoretical understanding of why organizational users (e.g., physicians) often resist against the use of advanced systems.

From a social exchange theory perspective, this study first extends its application to a HIS migration context by demonstrating that cost and benefit factors can explain a significant proportion of variance in physicians' use preference of a HIS. Second, this study also adds to the extant literature by suggesting the boundary to define costs or benefits could vary in different contexts. Specifically, we observed certain previously identified cost factor (i.e., transaction cost) could play a positive role in increasing the likelihood of direct use intention. The similar findings are also applied for the benefit factor as well, e.g., higher technical support will lead to a decrease of direct use intention.

This study also offers important practical implications for hospital management to increase the user acceptance in the process of mandatory system-system migration. Essentially, our findings unveil a set of antecedents that could influence a physician's direct vs. indirect use preference in this context. Hence, the hospital management could make specific strategies to foster the desirable type of use. To be specific, if direct system use is deemed desirable, strategies could be made to strengthen physicians' perceptions on high transaction cost and incentives. For instance, campaigns can be conducted to increase physicians' awareness on the possible adverse effects resulting from the migration process. In addition, attractive incentives schema such as bonus or favorable assessment need to be explicitly tied to the system use and to be announced to physicians before the actual migration.

While indirect use is often treated as a sign of resistance, recent research suggests that indirect use could effectively improve physicians' work performance by allowing them to retain "intellectual specialization" and focusing on their own medical tasks (Kane and Alavi 2008). To this end, hospital management could purposely foster the indirect use for a certain group of physicians whose expertise is precious inside the hospital. For instance, besides informatics officers, more dedicated clinical super users can be arranged to provide expert physicians in-time technical support. Such approach can effectively reduce their uncertainty of delegating the system-related work to others.

Conclusion

This study provides a nuanced understanding of how a physician decides his or her CPOES use preference in the context of mandatory system-system migration, an area demands more research attention. Through the lens of social exchange theory, we observed that previously defined contextual costs and benefits played different roles in affecting a physician's preference for direct and indirect system use. Based on our findings, hospital management could make specific strategies to foster the desirable type of use.

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